OECD Conference on the Financial Management of Flood Risk
Building financial resilience in a changing climate

PRESENTATIONS – SESSION 4

12-13 May 2016
Paris, France
Lessons from the OECD Risk Management Review on Paris floods

Charles Baubion
High-Level Risk Forum, OECD

Lessons learned from international comparison

<table>
<thead>
<tr>
<th>Cities or country</th>
<th>Year</th>
<th>River or event</th>
<th>Return period</th>
<th>Damages and losses (Bio €)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prague</td>
<td>2002</td>
<td>Vlatva</td>
<td>500 y</td>
<td>3,1</td>
</tr>
<tr>
<td>New-Orleans</td>
<td>2005</td>
<td>Katrina floods</td>
<td></td>
<td>90</td>
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<tr>
<td>UK</td>
<td>2007</td>
<td>Severn &amp; Thames</td>
<td>200 y</td>
<td>4,6</td>
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<td>Brisbane</td>
<td>2011</td>
<td>Brisbane</td>
<td>120 y</td>
<td>11,7</td>
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<tr>
<td>Bangkok</td>
<td>2011</td>
<td>Chao Phraya</td>
<td>&gt; 100 y</td>
<td>36,1</td>
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<tr>
<td>New-York</td>
<td>2012</td>
<td>Sandy floods</td>
<td>400-800 y</td>
<td>14,8</td>
</tr>
<tr>
<td>Central Europe</td>
<td>2013</td>
<td>Danube &amp; Elbe</td>
<td>100 y</td>
<td>12,1</td>
</tr>
</tbody>
</table>

Source: Romain Huret, 2010
What about Paris area?

- Economic impacts of a major flood today
- How to improve flood prevention?

Major assets at risks

463 km², 830 000 inhabitants
55 700 companies representing 620 000 jobs

Key government institutions, 295 schools, 79 hospitals, 11 637 power sub-stations, 140 km & 41 subway stations, 3 railway stations, sub-urban train, 85 bridges, 5 highways

Cultural heritage: the Seine Parisian banks part of UNESCO World Heritage, thousands of historical buildings, museums and art galleries

Environment: wastewater stations, industrial sites SEVESO, waste disposals, oil deposits
Assessing the impacts and its multiple dimensions

- Impacts on well-being, functioning of the institutions and companies
- Impacts on the environment and the cultural heritage
- Cascading impacts linked to network interruptions
- Macro-economic impacts: Île-de-France represents 30% of the French national GDP
Key messages

Impacts

A major event with large consequences

✓ Direct and indirect impacts on nearly 5 millions citizens and many companies
✓ Continuity of government
✓ Long duration that could exceed a quarter

A significant economic impact

✓ 3-30 Bio € of direct damages
✓ Impacts on critical infrastructures and businesses
✓ 0.1 to 3 % cumulated GDP losses over 5 years
✓ 10 000 - 400 000 job losses following the crisis

Setting inclusive risk governance mechanisms is a prerequisite for effective resilience policies

• Authorities: municipalities, region, state
• Policy areas: water, urban planning, emergency
• Scales: river-basin and metropolitan area
  → Multiple stakeholders
  → Coherence, decision-making, accountability

❖ Leadership and inclusive coordination mechanisms are essential to define joined-up strategies, agree on common targets and align actions

OECD Recommendation on the Governance of Critical Risks
**Integrating resilience into urban planning**

- Land use and urban planning regulation is necessary but not sufficient:
  - Enforcement of regulation is difficult
  - Lack of incentives to limit construction
  - Scarcity of non-built areas

- The opportunity of urban regeneration to foster innovation in resilient urban planning
  - Hamburg, Rotterdam, New-York, Copenhagen
  - **Great Paris**: 13 urban renewal projects in the flood plain

→ Mainstreaming climate resilience into smart and green city design and building a resilience culture

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**Strengthening the resilience of critical infrastructures**

- **Great Paris**: 30 bio EUR investment in public transportation infrastructure

- Resilience of critical infrastructures should be based on **robustness, redundancy** and **adaptability**

- 80% of infrastructures are privately owned or operated
  - Partnership with the private sector required
  - Contracting, regulating, incentivising
Fostering resilience in the private sector and SMEs

- Risk awareness in global corporations is on the rise
  - Risk Officers, (Re)insurance companies, past experiences
  - Risks can be part of investment decisions
  - Expectations
  - Ready to act to increase resilience but information needs
- What about SMEs?
  - 25% of SMEs never re-open after major disasters

- One-stop shop for risk information
- Incentive mechanisms for business continuity
  - Loire basin awareness campaign
  - Business continuity for dummies in the UK

CONCLUSION

- Comprehensive risk assessments can provide a strong signal to set-up ambitious resilience policies and invest in urban resilience. Transparency and openness is key to that aim
- Inclusive risk governance is a fundamental first step to engage whole-of-government / whole-of-society resilience efforts
- Key aspects of urban flood resilience:
  - Fostering innovation for resilient urban planning
  - Working closely with operators of critical infrastructures
  - Need to incentivise resilience in the private sector
- The power of international comparison and exchange of best practices to trigger policy change: Paris has now engaged significant efforts to reduce its vulnerability to this major risk
Resilient New Orleans
Flood Risk Reduction from Curb to Coast
12 May 2016

OECD Conference on the Financial Management of Flood Risk:
Managing flood risk at the city level

Jeff Hebert
Chief Resilience Officer
City of New Orleans
New Orleans in Context

New Orleans and the Nation
The Mississippi River drains 40% of the continental US.
25% of US waterborne exports are shipped through Louisiana’s five major ports.

Nature and the City
Land area: 169 mi² (438 km²)
Over 1/3 of that land is wetlands.
New Orleans in Context
Living with Risk
Coastal land lost since 1932:
1,900 mi² (4,920 km²)

Projected land loss by 2060, without action:
1,806 mi² (4,677 km²)

Data Source:
Coastal Protection and Restoration Authority, 2015 Coastal Master Plan
Our climate is changing.

Louisiana is experiencing the highest rate of relative sea level rise in the world:

1.3m by 2100

By 2050, Louisiana will likely experience extreme temperatures above 35°C on 80+ days per year. (currently <12 days/year)

Risk in Context
National Flood Insurance Program
National Flood Insurance Program
1984 Effective Flood Insurance Rate Map
(FIRM - Paper)

Grey indicates Special Flood Hazard Zone
- <0.2% Chance/Year
(500-year Flood)
National Flood Insurance Program
Special Flood Hazard Areas

Based on 1984 Effective Flood Insurance Rate Map (FIRM)

Average Flood Insurance Premium:
$961/year (Sep 2015)

Blue indicates
Special Flood Hazard Zone
<0.2% Chance/Year
(500-year Flood)

Risk in Context
Disproportionate Flood Risk
Local Flood Risk Mitigation
Investment Approach
We are shaping the future New Orleans.

We will:
- Advance coastal protection and restoration
- Invest in comprehensive and innovative urban water management
- Incentivize property owners to invest in risk reduction
- Create a culture of environmental awareness at every stage of life
- Commit to mitigating our climate impact

We are a city that embraces our changing environment.
From Curb to Coast

Urban water management and coastal defenses, both critical to a resilient urban delta.

Source: Waggonner & Ball Consulting Team

Flood Risk Reduction Investments
Storm Surge Protection
West Closure Complex
Swing-arm Surge Gate and World’s Largest Pumping Station

Flood Risk Reduction Investments
Urban Water Management & Integrated Infrastructure
17th Street Outfall Canal Lakefront Closure & Pumping Station
Lakeview, New Orleans

17th Street Outfall Canal Wall Improvements
Lakeview, New Orleans
USACE SELA Urban Drainage Projects
Uptown, New Orleans
1930s WPA Project “Sunken Garden” Precedent
Lakeview, New Orleans

Wildair Rain Garden - Dry
Gentilly, New Orleans
Infrastructure Investments
Scaling Pilot Projects
Mirabeau Water Garden

- 25-acre site of former convent of the Sisters of Saint Joseph
- Designed to temporarily store up to 38,000 cubic meters of water to mitigate flooding
- Site will eliminate flooding caused by 10-year storm within watershed.
- Flooding from a 100-year storm will be reduced by 72%.
- Designed to serve as a space for recreation and environmental learning

Pontilly Neighborhood Stormwater Network
Pontilly Neighborhood Stormwater Network

- Combines improvements to the Dwyer Canal with a network of interventions along streets, in alleyways, and within vacant lots designed to store and slow stormwater.
- Will reduce flood risk and beautify green spaces in the Pontchartrain Park and Gentilly Woods neighborhoods.
Benefits of the Projects

- Reduced risk of flooding and subsidence
- Neighborhood beautification & redevelopment
- Recreation & health
- Environmental awareness

Infrastructure Investments
Risk Mitigation Returns
National Flood Insurance Program
Special Flood Hazard Areas

Based on 1984 Effective Flood Insurance Rate Map (FIRM)

Average Flood Insurance Premium:
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National Flood Insurance Program
Special Flood Hazard Areas

2016 Approved Preliminary Digital Flood Insurance Rate Map (DFIRM)

Blue indicates
Special Flood Hazard Zone
<0.2% Chance/Year
(500-year Flood)
National Flood Insurance Program
New Orleans Special Flood Hazard Area Change

2016 Approved Preliminary Flood Insurance Rate Map

Outfall Canal
Walls and Closures

Urban Drainage
Projects

Surge
Barrier

Major Project

Special Flood Hazard Area Change

\- SFHA Decrease

\- SFHA Increase

National Flood Insurance Program
Special Flood Hazard Area Change Detail

2016 Approved Preliminary Flood Insurance Rate Map with 1984 FIRM

Special Flood Hazard Area (SFHA)

\- 1984 SFHA

\- 2016 SFHA
Results of New Flood Insurance Rate Map (FIRM) Adoption:

Insurance rates will decrease for approx. 53% of properties.

Rates will increase for approx. 3% of properties.

Avg. flood policy in New Orleans: $961

Those in new “X zones” will be <$500 for $250k coverage.

City is working with FEMA to adopt latest building codes to achieve 5% premium reductions in 2017.

resilientnola.org
@resilientnola
How can insurance loss data increase resilience

Norwegian insurance system

- Nat Cat= Act of God - not risk-based
- Solidarity system- “no one’s fault”
- Urban flooding= not an “Act of God”

- Included in property insurance = nearly 100 % penetration

Natcat coverage automatic included (mandatory) under the “fire” insurance
Urban flooding: 70% of insurance loss

2/3 of Europeans live in cities

Insurance pay outs 2008 - 2014

River flooding 5%
Landslide 5%
Vannforsuring 44%
Storm surge 22%
Urban flooding 10%

Blue + red = Urban flooding

Holistic risk picture: You need collaboration cross sectors

Insurance Industry
- Risk management
- Assessment
- Quantify & Calculate
- Risk transfer products

• Collects local disaster loss data
• Compensate, don’t mitigate

The value of collaboration

Governments
Private Sector
Local Authorities
Public Agencies
Insurance loss data help authorities (mitigators) understand risk.

Pilot project:
Using insurance claims data to strengthen municipalities’ efforts to prevent climate-related natural hazards

Collaboration project between Finance Norway
Western Norway Research Institute
Norwegian University of Science and Technology
What kicked off the project

- Increase in precipitation combined with old water and sewage-infrastructure have lead to increase in damages and insurance claims
- Frustrated customers – repetitive damage (same locations)
- The Municipalities don’t have data showing risk- and vulnerable areas
- Municipalities have tried to get insurance loss data from insurance
- Needed exemption from data protection law

What kicked off the project?

- In order to improve adaptation, and to be able to prioritize, and to take the right, optimal decisions, you need to understand what is at risk and where are the “risk zones” (vulnerable areas).

- The report NOU2010:10 recommended to (and by that challenges the insurance industry):
  - “Establish a database for public use and research using aggregate, anonymised data on climate-related damage from the insurance companies and the Norwegian Natural Perils Pool”.

Finance Norway
First joint «public/private» project

- Initiated by Finance Norway - lead the project in close connection with researchers
- Financed by Finance Norway and partly the Ministry of Climate and Environment
- Build on dialog and feed-back from municipalities
- Ten pilot municipalities joined
- Project period: Sept 2013 to Feb 2015

Main goals

- Understand how insurance loss data can help climate - resilient work in the municipalities
- Strengthen municipalities’ knowledge base for preventing water-related natural hazards
- Secure and preserve an insurance system against nature- and water-based hazards
  - Avoid an increasing number of damages and
  - Higher premiums, more differentiated premiums and withdrawal of insurance coverage
Type of data

- Type of insurance loss data
  - Loss data down to address
  - Nat Cat loss data: storm, storm surge, river flooding, landslides
  - Storm water and back flow damages (urban flooding)
  - Private, companies and municipalities building

- Other indicators
  - Damage date, cause of damage, amount paid in compensation

The project step-by-step

[Diagram showing the steps of the project]

- Insurance companies
  - Collect data
- Finance Norway
  - Transfer data
- WNRI/NTNU
  - Import data
- Municipalities
  - Analyse data
  - Use data

[Finance Norway logo]
Main conclusion

• Generally
  – Increase collaboration within the municipalities (planning og technical)
  – Got new insights into risks previously unknown
  – Improved understanding of how climate change affects society

• Land-use planning
  – Improved knowledge base to
    • select areas with the lowest possible risk of natural hazards
    • prioritize security measures

• Construction and maintenance of water and sanitation
  – Improved knowledge base for
    • prioritizing management, maintenance, rehabilitation, and reinvestment
    • collaboration between municipal water/sanitation and planning units

• Preparedness
  – Improved knowledge base for risk and vulnerability analyses

Oslo city’s own loss data
Insurance urban flooding loss data
Improving Resilience to Flood Risk: The case of New York City

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Chairman, OECD Board on Financial Management of Catastrophes
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OECD Conference on the Financial Management of Flood Risk:
Building Financial Resilience
May 2016

Mega-city clusters dominate the world economy.

A case study with one of the largest cities in the world, New York

Key Questions from the Mayor’s Office

What are current and future flood risk levels in NYC? Can we quantify these in a transparent manner?

Which strategies could be implemented to reduce the costs of future floods and save lives?
- What are their respective costs and benefits?
- Is it economically beneficial for NYC to invest today in making buildings flood resilient, or in flood-protection infrastructure?
- Who should pay for such investments? What innovative financial instruments can be designed to do so?
Research at the crossroads of several disciplines

- Climate science (storm, surge, flooding)
- Adaptation
- Cost-benefit analysis for large-scale urban projects
- Finance
- Behavioral economics

Evaluating Flood Resilience Strategies for Costal Megacities, 
*Science*, Vol. 344, pp. 473-475 (plus supplemental material online) 
Joint work with Aerts, Botzen, de Moel (VU Amsterdam), Emanuel (MIT), Lin (Princeton)
Why the New York Area?

- One of the largest coastal mega-cities
- Important economic hub for the U.S. and international community (tourism, trade, financial markets)
- High urban exposure to flooding
- $80 billion flood-related losses from Superstorm Sandy in 2012
- Massive impediments to flood resilience (8 out of 10 residents and 9 out of 10 small businesses were uninsured against flood losses)
- Costly delays in restoring and upgrading damaged infrastructure
First, one needs to assess flood risk
Overview of Model Integration and Data Sources

**Hazard**
- Hurricane-ADCIRC
  - 549 storms
  - Probabilities ($p_i$)
  - Surge heights
  Source: Lin et al. (2012), *Nature Climate Change*

**Exposure**
- NYC building stock
  - 33 categories
  - Values per census block ($value_{n}$)
  Source: NYC Office of Emergency Management

**Inundation model**
- LiDAR elevation
- Inundation depths per census block ($hazard_{i}$)
Source: Aerts et al. (2013), *Risk Analysis*

**Vulnerability**
- HAZUS - flood damage model ($L_{mn}$)
  - Depth-damage curves ($f_{n}$)
  - Building, contents, vehicle damage
  - Mark up infrastructure and business interruption damage ($a$)
  Source: Federal Emergency Management Agency

**Costs**
- Barrier designs
- Unit costs coastal protection and flood-proof buildings
Source: Aerts et al. (2013), *ANYAS*

**CBA**

**AAL**

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Flood Risk Management Strategies

**S1: Flood-proof buildings**
- New, or existing buildings
- +2ft, +4ft, or +6ft above the current ground level
- Applied to the 1/100 or 1/500 year flood zone

**Elevated building**

**Wet-flood proofing**

**Dry-flood proofing**

Source: Aerts et al., 2013, *ANYAS*
**S2a: Flood Protection ‘Environmental Dynamics’**

Three storm surge barriers
- Arthur Kill
- Verrazano Narrows
- East River

Coastal protection near barriers
Open system to preserve ecosystem dynamics

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**S2c: Flood Protection Barrier NYC-New Jersey (NJ)**

Large outer harbor barrier
Large reduction coastline
Protects larger area in NJ
May disrupt water flows
S3: Hybrid Solution of Local Protection

Overall Methodology and Model Framework

Steps for economic evaluation of each strategy:
1) Estimate the investment and maintenance costs ($C_t$)
2) Estimate the reduced ($t$) average annual flood loss ($B_t$)
3) Cost-Benefit Analysis over a time horizon ($T$) (here, 100 years)

\[
\text{Net Present Value} = NPV = \sum_{t=1}^{T} \frac{(B_t - C_t)}{(1+r)^t}
\]

\[
B/C \text{ ratio} = \sum_{t=1}^{T} \frac{(B_t)}{(1+r)^t} / \sum_{t=1}^{T} \frac{(C_t)}{(1+r)^t}
\]

Main Uncertainties Accounted for in the CBA

**Lifetime barriers:** \( T = 100 \) or 150 years

Investment timing barriers: delay by 25 years

**Discount rate:** \( r = 7\% \) or \( r = 4\% \) (aligned with EPA: 2.5%; White House: 3%-to-7%)

Effectiveness dry and wet flood-proofing:
- high (-88% and -50%) or low (-75% and -30%) scenarios

**Model uncertainty:** 95% confidence interval based (Aerts et al., 2013, *Risk Analysis*)

Climate change effects on risk: 4 Global Circulation Models (Lin et al., 2012, *Nature Climate Change*) and 2 NYC sea level rise scenarios (NPCC, 2010)

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Results (communicated to NYC Mayor's Office and other decision makers)

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<thead>
<tr>
<th></th>
<th>Where/how much</th>
<th>Environ dyn.</th>
<th>Bay closed</th>
<th>NJ-JY connect</th>
<th>Hybrid solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total investment</td>
<td>NYC</td>
<td>$16.9-21.1 billion</td>
<td>$15.9-21.8 billion</td>
<td>$11.0-14.7 billion</td>
<td>$6.4-7.6 billion</td>
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<tr>
<td>Total investment</td>
<td>NJ</td>
<td>$2 billion</td>
<td>$2 billion</td>
<td>n/a</td>
<td>$4 billion</td>
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<tr>
<td>Total investment</td>
<td>NYC+NJ</td>
<td>$18.9-23.1 billion</td>
<td>$17.9-23.8 billion</td>
<td>$11.0-14.7 billion</td>
<td>$10.4-11.6 billion</td>
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<tr>
<td>Maintenance</td>
<td>NYC+NJ</td>
<td>$98.5 million</td>
<td>$126 million</td>
<td>$117.5 million</td>
<td>$13.5 million</td>
</tr>
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</table>

**Costs**

None of these strategies are cost effective (too expensive) for the City of New York if implemented today and paid by the city alone

Middle climate change scenario: GFDL climatology model (higher storm frequency and SLR) from NOAA’s Geophysical Fluid Dynamics Laboratory
Who Should Pay for NYC's Resilience Investments?

• A city that generates significant positive externalities to the rest of the U.S. (trade, tourism, port) and the world (financial market)

• If positive externalities are captured and the cost is shared more widely, then the benefit-cost ratio will make these resilience investments much more appealing financially for the city

A Proposal for “Resiliency Investment”

Possible Solutions:

1) NYC issues a “Resiliency Bond” to cover their share (spreads upfront cost; designed according to a specific standard)

2) Establish a NYC Resiliency Fee to be paid by all tourists who visit the city (similar to the current 9/11 security fee on each airplane ticket)

$10 * 50 million tourists/year = $500 million/year = $5bn in the next 10 years

Sources:
Since 2010 the Wharton Risk Center has published over 100 journal articles, reports, working papers or policy Briefs on flood risk, resilience and insurance.

All accessible at: http://opim.wharton.upenn.edu/risk/papers

Merci.